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Institute of Plant Industry, Indore

PRESS NOTICES ON THE FIRST QUINQUENNIAL REVIEW OF THE WORK OF THE INSTITUTE

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Press Notices on the First Quinquennial Report on the work of the Institute

I. INTRODUCTION

The Institute of Plant Industry at Indore was founded on October 24th, 1924, for the following objects:—

(*a*) the establishment of an agricultural research Institute for the Indian Central Cotton Committee at which fundamental investigations on cotton can be undertaken. In addition, a critical study of cotton growing on the black soils of India, and the production of improved cottons for Central India and Rajputana, both for dry and for irrigated conditions, will be undertaken;

(*b*) the training of post-graduate students nominated by the Central Cotton Committee;

(*c*) the provision of an agricultural centre for the States of Central India and Rajputana, which will serve as an object lesson for the development of this portion of India and at which officers and cultivators, nominated by the Darbars, can be trained.

In the execution of this project, the plant has been regarded as the centre of the subject. The crop has been studied in relation to the soil in which it grows, to the conditions of village agriculture under which it is cultivated and with reference to the economic uses of the product. In other words, the development of the crop has been considered as a biological whole and not piecemeal. Every effort has been made to avoid the fragmentation of the subject, now such an alarming feature of the agricultural departments of the Empire. Experience at the new Institute soon showed that when the problems, presented by cotton and associated crops on the black soils of India, are dealt with in a comprehensive manner, results of practical value can at once be obtained. Further, the success of the new methods confirmed the suspicion that the present organization of agricultural research in India on the basis of the separate

sciences leaves much to be desired. It can never, from the nature of the case, achieve anything worth while.

In 1929, when the work had been in progress for five years, it was decided to issue a statement dealing with the purpose, conduct and progress of the Institute* so that the subscribers would be in a position to see not only what had actually been accomplished but also to understand the nature of the work in progress. The first quinquennial report was published in 1929 by the Oxford University Press under the title *The Application of Science to Crop-production, an experiment carried out at the Institute of Plant Industry, Indore.* The book has been very favourably reviewed in a number of scientific journals and newspapers in the United States, Great Britain, India, Ceylon, and other countries. These notices are reprinted in the following pages.

* The Institute of Plant Industry is supported by grants from the Indian Central Cotton Committee and twenty States in Central India and Rajputana. No financial assistance of any kind has been obtained either from the Government of India or from any of the Provincial Governments. In 1924, the following eight Central India States joined the scheme: Indore, Datia, Dhar, Dewas (Senior Branch), Jaora, Ratlam, Sitamau, and Narsingarh. During the last three years, the following additional twelve States of Central India and Rajputana have, in order of date, agreed to support the Institute—Tonk, Bijawar, Barwani, Jhalawar, Bikaner, Rewa, Jaipur, Bundi, Partabgarh, Bagli, Orchha, and Bharatpur.

II. REVIEWS

AN EXPERIMENTAL INSTITUTE OF PLANT INDUSTRY IN INDIA

Experiment Station Record, 62, 1930, p. 701

Notwithstanding the elaborate development of research systems in a number of countries to-day, the organization of agricultural research upon an institutional basis is a relatively recent undertaking. It was less than 80 years ago that the first experiment station organized as a public institution was established at Möckern and only 8 years earlier that Lawes and Gilbert began their epoch-making studies at Rothamsted. Since those historic days various plans of organization have been devised and several promising ideas have been more or less extensively tested, but it is not surprising that there is still much diversity of opinion and practice. Few would be so bold as to assert that the ideal type had as yet been worked out in any final way, and interest still attaches to ventures not fully conforming to the customary methods.

What appears to be an innovation in some respects has been in operation in India since 1924 under the name of the Institute of Plant Industry at Indore. An account of this enterprise, prepared by its sponsors, Director Albert Howard and Gabrielle L. C. Howard, a botanist of its staff, has recently become available under the title of The Application of Science to Crop-Production. This account is not only of significance for what it reveals as to the progress of the Institute itself, but as a contribution to the theory of research organization in general.

In India, as in many other regions, reliance for agricultural research has thus far been most exclusively on what may be termed the general-purpose institute, with the usual subdivisions into the separate sciences. This arrangement, we are told, has been found to be, under the special conditions there presented, by no means ideal. "It was soon discovered," the authors state, "that the problems presented in the improvement of a crop cannot be split up into a number of parts without grave detriment to the whole. To attempt to do so not only leads to the fragmentation of the problem but also seriously limits that freedom which is so essential to the

scientific investigator of economic questions. The center of the subject of crop production must always be the plant itself, which obviously can only be effectively studied in relation to the soil in which it grows, to the conditions of village agriculture under which it is cultivated, and with reference to the economic uses of the product. . . . The need for the broadening of the subject, as well as for the development of new methods and new lines of attack, became more and more insistent. The only practical solution of the difficulty appeared to lie in making crop-production one of the main sections of agricultural research work in India and in abandoning the present fragmentation of the subject altogether. As it is not easy to change any form of organization from within, this involved the foundation of a new institute for crops, at which the development of the plant could be studied as a biological whole and not piecemeal."

Having these views in mind, Director Howard, who had previously been connected with the research institutes at Pusa and at Quetta, became in 1919 agricultural adviser to the States in Central India and Rajputana, a region without an experiment station, and immediately took steps to organize a research institute for crops which would directly embody the ideals referred to above. After some disappointments and delays the plan was approved in 1924, and work was begun late in that year. A tract of 300 acres of land was placed at the disposal of the institute by the Indore Durbar for 99 years at a nominal rental. Eight States in the region contributed a total of 20,800 rupees ($6,739) for annual maintenance, and by 1929 this support had been increased to 16 contributing States and a total of 44,550 rupees per annum. The principal funds, however, were obtained from the newly-established Indian Central Cotton Committee, which granted 200,000 rupees toward a capital cost of buildings and equipment and has been supplying 100,000 rupees each year for maintenance. From still other sources benefactions aggregating over 100,000 rupees were secured. Thus, the institute was established as the unique combination of public and private, "an example of the union of diverse interests for a common purpose." In the beginning its accounts were handled by governmental agencies, but in 1928 it was incorporated as a distinctive entity with a representative board of governors.

The objects of the institute are set forth as threefold. They include "the investigation of all matters relating to the production

and improvement of raw cotton in India," the agricultural development of the contributing territories, and the provision of an agricultural center to serve as an object lesson and to provide for the training of both advanced students and practical cultivators.

The greater part of the interval since the institute began operations has necessarily been devoted to the preliminary development of its holdings. Much of the land was rough, undrained, and inaccessible, and it was not expected that all the fields could be made suitable for experimental work until the present season. Three sets of buildings were erected, a group of laboratories, the farm buildings, and a "model village" for a portion of the staff, for visitors, and for certain laborers. Because of the relatively small funds, the laboratory group is of simple construction but contains office, library, and lecture room facilities, as well as a chemical laboratory fitted up especially for work in soil science and a set of botanical laboratories. The farm appliances were designed to employ no power beyond the reach of the average well-to-do cultivator of the region, but the farm buildings embody much specialized construction, including extensive arrangements for composting and a small cotton ginning factory.

As the Indore Institute owes its existence to the grants made by the Central Cotton Committee and was formed primarily for research on cotton, the investigations with this crop are the principal concern of the staff of about 15 scientific workers. Thus far the cotton studies have dealt with basic questions, genetics, and agronomy. Much time has been given to a botanical survey and classifications of the multitudinous types of cotton now found in India. The chromosome numbers of 28 types have been determined, and a preliminary study has been made of the root systems and of the influence of environmental factors on the lint. It has been found that the adaptability of certain types to the local conditions is often closely related to their root systems, the failure of American types like Cambodia as a rains crop on the black soils being attributed directly to this cause, and it is believed that much of the breeding work of the future will deal with the life history of the root system and its relation to the type of soil quite as much as the growth of the shoot and the amount and character of the fiber. The cause of the shortening of the fiber under less favourable environmental conditions is another problem which is regarded as very important if a product of uniform grade is to be maintained.

One of the consequences which the Howards ascribe to "the fragmentation of agricultural problems in the past" is the difficulty of considering in a comprehensive way the influence of adverse soil factors on the susceptibility of the plant to disease, and the reasons why a plant in health remains immune to attack of certain insects or fungi. "There is a vast literature on some of the fragments of this question, but for the most part it concerns various insects and fungi, is unrelated to the essential soil factors, and has been carried out on much too narrow a basis. The wider aspects of disease and immunity are being taken up at Indore and already progress is being made. Evidence is being obtained that the soil conditions necessary, say for an insect epidemic, must begin to operate some months before the actual insect appears and that the sequence of events is somewhat as follows: Unfavourable soil conditions lead to changes in the acidity and other characters of the sap and so prepare suitable food for the insect or fungus which thrives just as long as this food supply is available. Favourable soil conditions, on the other hand, bring about a marked increase in the resistance of the plant. Further, insects and fungi do not spread from the susceptible area to the healthy crop alongside. An investigation of the causes of the red leaf of cotton on these lines is being carried out."

Despite the present and potential importance of the cotton crop in India, efforts at improvement thus far have dealt largely with the securing of better varieties, and the agronomic and soil factors involved have received little attention. However, it is pointed out that "improved varieties give some increase in the total yield, but such results are small compared with the enormous increment made possible by better agricultural conditions," and it is believed that "the cotton work of the future must be a well-balanced combination of agronomy and genetics with soil science." For this reason cotton agronomy has been made one of the leading subjects of research at Indore. This phase of the work has recently been aided by a special contribution from a wealthy merchant of India, Sir Sarupchandji Hukamchand, for the maintenance of a scholarship in cotton agronomy open to distinguished graduates in science of the Indian universities.

At least four soil factors have been found to limit seriously the growth and yield of cotton on the black soils of the region. These are the loss of fertility by perennial grasses, the lack of control of

run-off during the monsoon rains, insufficient permeability during the second half of the monsoon because of the excessive development of soil colloids, and the low content in these soils of organic matter. All of these factors retard the growth of cotton through a depriving of the plant of nitrogen. The soil colloid problem is regarded as particularly complex, but for the remaining difficulties remedies have already been suggested which it is thought will be readily applicable and effective.

Although one of the outstanding characteristics of the institute is its concentration of effort upon cotton, attention has been given to some supplementary activities as opportunity has permitted. Among these have been an improvement of irrigation practice; the development of substitute crops for the opium poppy, production of which, it is stated, is being given up; the improvement of the work cattle by the better feeding possible with an increased use of silage; and the encouragement of the introduction of suitable improved implements and machines.

Considerable thought has been given to the dissemination of the practical results obtained by the institute. Although primarily a research and not an educational agency, a small number of qualified students are being accepted for training and return to strategic points in their respective districts. For extension purposes, the institute has arranged a number of cultivators' meetings on its own grounds at which demonstrations and lectures on selected topics have been dealt with at some length. Gratifying results are already reported from many of its contributing constituencies. In the Holkar State, a new department of rural development has been set up, working in very close touch with the institute, and is just opening a farm of its own for the improvement of the Malvi breed of cattle. A new experimental farm is being started by the Maharaja of Bikaner on the new Gang Canal for dealing with the local problems presented in the best use of the available supply of canal water. In Jaipur, a large cattle and demonstration farm is being operated at Basi, and work among the cultivators is in progress. In two of the Central India States, agricultural schools are being opened in connection with new demonstration farms. In all cases where such demonstration farms are being started or work in the villages is being undertaken, the State officers in charge of the work are sent to the institute for a definite period of training, and the advice of the institute is sought before any projects are un-

dertaken. Thus, we are told, "the original idea that the institute would serve as a center of agricultural research and of agricultural information in Central India and Rajputana has already been realized. More and more interest is being taken by the durbars in the work, and more and more advantage is being taken of the results. It is now generally recognized that the institute has become an important research and training center, which exports ideas and information on rural reconstruction as well as improved varieties of crops and new methods of cultivation. It is already acting as a stimulus in general rural development. The States have realized the advantage of possessing an up-to-date experiment station in their midst, so that their resources can be utilized on definite and practical local schemes. In this, there is great economy, in time as well as in money. In a single generation it is more than probable that some at least of the contributing States will reconstruct their villages and incidentally double their land revenue."

The concluding chapter of the book deals more or less abstractly with the organization of agricultural research, including such phases as the relation between central and local research stations and the clear differentiation between research and demonstration. On the latter point a strong plea is made for a distinctive line of cleavage. "Two branches—research and demonstration—which are both equally important, should be developed in every agricultural department. The staff in every branch should be carefully selected for the work they have to perform." "The idea that to be successful every officer working in the districts must attempt something in the way of research must be given up entirely." "The art of demonstration and of inducing cultivators to adopt improvements is as important as that of research, and every endeavor should be made to develop this branch of the subject as a separate and as an honored profession."

"The relation between the Institute of Plant Industry at Indore and its contributors," it is stated, "has been arranged in accordance with this conception. All the research work is carried out at the institute, where ample facilities for scientific investigations and a good library have been provided. The demonstration work is carried out by the contributing States themselves, and it is hoped that in time each State will have a demonstration farm which will serve as a center for local propaganda. Liaison is maintained by the visits of the director to the States, of State officials and

agricultural workers to the institute, by cultivators' meetings, and so forth."

As to the larger question of an Empire organization, the policy advocated is definitely that of decentralization. "The ideal system of conducting agricultural research in the Empire," it is declared, "seems to lie in the simplification rather than in the elaboration of the organization. All that is necessary appears to be to provide each region with a research institute of its own, to do everything possible to increase the efficiency of these centers, and to allow the workers every facility for un-official consultation and discussion, such as is provided by the meetings of the British Association, the Indian Science Congress, and similar bodies. Better men are needed not more machinery. Any funds that can be provided in the future for agricultural research should be devoted to the payment of competent investigators and to the provision of the means necessary for these men to work out their ideas. In other words, agricultural research must be made a profession. Until this is done, no real progress is possible."

These views are interesting, though put forward in connection with conditions more or less unique and presumably not intended as generalizations for universal adoption. Some of them are in essential accord with the prevailing thought in this country and would find corroboration in its experience. Others would meet less ready acceptance. Substantially all, however, who have studied the matter will agree that there is much food for thought in the final sentences: "Any attempt to overstrain systems of organization in the hope that they may replace competent investigators can only end in failure. In research, the man is everything; the organization is a minor matter."

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION.—An Experiment carried out at the Institute of Plant Industry, Indore. Von Albert Howard u. Gabrielle Howard. Verlag Humphrey Milford, Oxford University Press 1929. 81 S., 12 Bildtafeln, 7 Textabb. Pr. 9 sh.

Der Tropenpflanzer, 33, 1930, s. 171

Das Buch ist das Ergebnis der langjährigen Tätigkeit der Verfasser in Indien. Die Gründung des "Agricultural Research

Institute Indore," 1924 ist ihr Werk. Über Einrichtung, Gelände, Gebäude und Kosten der Station werden genaue Angaben gemacht. Das Institut in Indore arbeitet vor allem an der Hebung der Baumwollkultur auf den schwarzen Böden der Zentralstaaten Indiens und Rajputana. Bei der Züchtung sind die Ziele: 1. für die Malwa-Hochebene die Gewinnung von frühreifen Sorten mit einer Faser, die es ermöglicht, Garne von mindestens Nr. 20 herzustellen; 2. für die Niederungen von Zentralindien eine verbesserte Sorte zu erzielen; und 3. die Feststellung der geeignetsten Sorte für gut bewässerbares Land.

Die Ursachen der Vermischung der Sorten werden erörtert und hingewiesen auf die Vermischung durch den Dung des Zugviehs bei Verfütterung von Baumwollsaat, deren Keimfähigkeit nicht durch Kochen oder Mahlen zerstört worden ist. Bei Ochsen, gefüttert mit 2 lbs Baumwollsamen, ergaben die Untersuchungen des Nachtdungs, dass je Tier 160 unverletzte Samen den Darm passiert hatten, deren Keimfähigkeit allerdings nur noch 1 v. H. betrug.

Eine andere Aufgabe des Instituts ist die Verbesserung der Methodik der Bodenbearbeitung und Kultur der Baumwolle, immer unter Berücksichtigung der Durchführbarkeit in den Betrieben der Eingeborenen. Unkrautvertilgung, Wasserregelung und Anreicherung des Bodens mit organischen Stoffen sind die Hauptmittel. Nach Meinung der Verfasser lässt sich der Ertrag an Saatbaumwolle auf der Flächeneinheit durch verbesserten Ackerbau verdoppeln, was die einfachste Lösung des indischen Baumwollproblems darstellen würde.

Weitere Arbeiten des Instituts beschäftigen sich mit Bewässerungsfragen, Rinderzucht usw. Ein Anhang bringt ausser einem Verzeichnis der Veröffentlichungen der Verfasser zu dem Thema verschiedene Übersichten über die Angelegenheiten des Institutes. Das Buch ist für jeden, der sich mit der Kultur der Baumwolle und der Verbesserung ihrer Anbaumethoden beschäftigt, von Wert.

Ms.

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION

By Albert Howard and Gabrielle L. C. Howard.
New York: Oxford University Press. 81 pages, illus., 1929. $ 3

Journal of the American Society of Agronomy, 22, 1930, p. 670

This brief monograph will probably be of chief interest to those charged with the administration of agricultural research institutions, for it deals largely with the organization, expenditures, and accomplishments of the Institute of Plant Industry founded at Indore, India, in 1924, although agronomists interested in cotton will also find in its pages much of value in their field. The Indore Institute is unique in that it is an expression of the opinion that the organization of an agricultural research institute on the basis of practical agriculture, on the one hand, and on the basis of the separate sciences, on the other, is not an ideal arrangement. This led to the foundation of an Institute for crops at which the development of the plant, in this case cotton, could be studied as a biological whole.

The chief purposes of the Institute of Plant Industry at Indore are given as (*a*) the fundamental investigation of cotton and a critical study of cotton growing on the black soils of India, together with the production of improved cottons for Central India, both for dry and irrigated lands; (*b*) the training of post-graduate students; and (*c*) the provision of a demonstration of the possibilities of development of this portion of India. The senior author is Director of the Institute, and together the authors have devoted the past twenty-five years to a study of the means by which botany could profitably be applied to the crops of India. A list of their papers published since 1905 is appended and serves to illustrate the nature and scope of their investigations. (J.D.L.)

SCIENCE IN CROP-PRODUCTION

The Application of Science to Crop-Production: an Experiment carried out at the Institute of Plant Industry, Indore. By Albert Howard and Gabrielle L. C. Howard. Pp. v.+81+12 plates. (London: Oxford University Press.) 9*s*. net

Nature, 124, 1929, p. 974

In many countries, up to the War period, the career of agricultural research was one of struggle and piecemeal growth. Exceptions were to be found in the steady evolution of research institutes in some European countries; the United States had inaugurated a wide organization; and in India an interesting feature was the establishment of certain 'central' research stations. Tropical agricultural research was, in general, under neglect. The decade now ending will always stand out as a period of informed interest and of determination to develop agriculture by application of the sciences. It is of the British Empire that this is particularly true, and the Imperial Agricultural Research Conference of 1927 may prove to merit a permanent place in the history of agricultural development.

Movement has been in a number of directions. Apart from expansion of existing centres, there has come 'industry' research as exemplified in the Empire Cotton Growing Corporation's Research Station in Trinidad and the Rubber Research Institute in Malaya. The new Amani Institute in East Africa represents a novel form of 'central' research station, while the Imperial College of Tropical Agriculture in Trinidad gives the Empire its first tropical training ground. Agricultural research councils have recently been set up for the non-self-governing colonies and for India. From this new activity are emerging many problems, ranging over finance, the sciences, organization, and local political situations, and extending down to the recruitment, training, and status of the research worker. This is pre-eminently, therefore, a time which makes welcome any logical survey of the methods of inaugurating and conducting agricultural research on a large scale.

In the volume before us, Mr. and Mrs. Howard relate the story of the genesis, scope, and experimental work of the recently founded Institute of Plant Industry at Indore, Central India. Central India, a group of Indian States, is a large tract in which 'black cotton

soils' predominate. In 1919 it was decided to found an agricultural research station for the whole area, and Mr. Howard became Director of the Institute and Agricultural Adviser to States in Central India and Rajputana. Gifts of land and money were made by the States, and in 1924 the recently formed Indian Central Cotton Committee provided buildings and equipment and guaranteed a substantial annual income. By 1928 the Institute was incorporated and made fully autonomous; it is now financed by subscription and controlled solely by the subscribers. Thus was removed one of the difficulties of organised research, and one which the authors believe to have been a grave defect in British India, namely, the oppressive official control of work and organization by way of official control of funds. The circumstances of Central India made the broad task of the Institute clear. Work was concentrated upon cotton and along the following main lines; fundamental investigations on cotton, especially in relation to the characteristics of black soils and the production of improved varieties for those soils; the training of post-graduates and others; and the general stimulation of agricultural development in Central India.

General policy and development at Indore are of especial interest when taken as an illustration of the general case. The major considerations which are steadily associating themselves with large-scale agricultural research are grouped round experimental policy; organisation including finance; and the means of projecting research results into farming practice.

Upon experimental policy there are two rather divergent schools of thought. One would content itself with finding really competent research workers in the various sciences and giving them full working facilities and full freedom. It argues that all fundamental advances must in time inspire improvements of practice and that economic applications arise, and may be left to arise, unexpectedly from unfettered research. In contrast, the second school favours a survey of the economic situation and the practices of production, in the light of which a limited number of urgent but approachable problems should be selected. Experimentation should then be specifically directed to these problems. It should commence with a strong 'applied' bias and gradually find its way into the underlying fundamental scientific problems. In support of this it could be urged that any crop or domesticated animal offers literally infinite scope for experiment; that resources are limited;

and that, therefore the direction of research must to a fair extent be prescribed. In brief, the problem of guiding experimental policy is to maintain a live connexion with the practices of agriculture without depriving research of that measure of freedom which is vital to all scholarship. Flexibility of outlook is the fundamental necessity, for time and circumstances are bound to give suitable scope to both the alternative attitudes. At Indore, it is clear, faith in the man rather than the organization has been the guiding principle; and yet the economic bias has not been forgotten, for science is being applied to crop-production by progressive analysis of a number of clearly defined practical problems.

The organisation of a research institute involves finance, government, internal administration, staffs, buildings and equipment. In connection with each of these, current practice varies widely among agricultural research centres. Indore, by reason of the agricultural and political circumstances of Central India, is saved from many of the difficulties familiar elsewhere. It is, none the less, an extremely interesting example. In finance there is complete autonomy, and to this the authors attach great importance. By most praiseworthy restraint the Board of Governors has been limited in number to seven, of whom one, the Agent to the Governor-General in Central India, is *ex-officio* president. Three of the members represent the constituent States and three the Indian Central Cotton Committee. This body, small, and directly concerned in the ultimate aims of the Institute, may perhaps be looked on as, in principle, ideal of its kind. For it is unlikely to lose touch with essential aims by dissipating itself into committees the time of which is taken up by the *minutiæ* of internal administration. One of the most interesting chapters in the volume describes the lay-out and development of land and buildings, the stock, the equipment, and the working material in general. It is a rare and valuable guide for future undertakings.

How to project research results into agricultural practice is the remaining major consideration. Its great importance has in the past rarely been appreciated either by the research worker or by government or other financing body. In England it has been by no means neglected, and yet there are many farmers who, in such familiar practices as the use of fertilisers, still fail entirely to profit from the clear-cut principles which have long been familiar to science. At Indore the general problem has been resolved into

liaison on one hand and the scope and status of the Station on the other. Students trained and sent out into the States are regarded as the most effective agents for liaison with the supporters of the Institute. With the help of a certain number of scholarships, it has been possible to commence the training of Indian university graduates as specialists in cotton. Agricultural officers and subordinates are urgently needed for the contributing States, and arrangements have been made to train present occupants of these posts and to recruit new ones. The aim is not so much to afford a knowledge of agricultural science as to stimulate an informed interest in the development of the countryside. A novel and most valuable feature has been a short course for a certain number of State officers connected with the revenue departments. Training, or the making of liaison agents, is extended even to the cultivator. The labour staff of the Institute is maintained as a fluid body from which trained men are gradually drafted to the districts where, in various capacities, they are expected to become the foci of an improved agriculture.

Indian experience has made clear, the authors feel, that a 'central' research station as formerly conceived cannot succeed. Unless it produces results of economic value it will sink in the general estimation and lose financial support. But if it produce such results, how is it to ensure that they are adopted in practice? In British India the provincial stations are the only medium available. These, however, have duties, interests, and researches of their own, and in effect, cannot subserve the central station. It is urged, therefore, that, together with central station for any 'area', there should be established demonstration farms in the component 'districts'. These should engage in no scientific work, but concentrate on inducing the cultivator to adopt the improvements emanating from the central station. Indore is conceived upon these lines and the States are providing the necessary demonstration farms. It is, perhaps, a fair criticism that in some countries this simple partition of 'research' and 'demonstration' would offer difficulties. Men sufficiently competent and interested to have charge of demonstration farms and propaganda would not always be willing to eschew investigation and subdue originality. Moreover, for areas varying sharply from place to place in soil and other circumstances, full experimental confirmation of central station results in representative districts would be essential.

Of actual experimental achievement, despite the short life of the Institute, there is a good deal to show. The comprehensiveness of the policy is a noteworthy feature, and the essential aim is to study the cotton plant as actually grown by the cultivators. Improved varieties usually offer, in circumstances of somewhat backward husbandry, the readiest chances of advancing agriculture, and provided a seed supply be organised, they are the swiftest means of gaining the cultivator's good will. But even in India, increases in yield from improved varieties are usually of the order of only 10 per cent. Far more substantial increases may be effected by cultivational improvements, and the authors hold that on the black soils better methods may be expected to double the output per acre of cotton. With plant breeding are therefore linked extensive studies upon weed eradication ; upon the control of water during the monsoon to prevent erosion and soil deterioration; upon soil permeability; and upon the organic matter content of black soils. It is believed—and the experiments now bear witness—that in these four questions are to be found the essential limitations to output per acre. Well-irrigation, the maintenance and improvement of stock, and appropriate ploughs, crushing mills, and other mechanical appliances, are further subjects of investigation. To ensure that improvements in these directions pass into practice, the Institute arranges supplies to cultivators on simple financial terms.

In each of the fields selected the experimentation projected or in progress is very comprehensive. Moreover, while closely regarding the underlying fundamental scientific questions, it is directly linked with the circumstances of husbandry. Plant breeding is based upon a study of all obtainable forms of Indian cotton, to which will be added, later, other Old World cottons. Botanical surveys of Indian cottons have already been made, but these, for plant breeding and husbandry, are of no more than cataloguing value. The quality or manufacturing characteristics, the adaptation to soil, season, and cultivational practice, and resistance to diseases and pests, are of first importance. To all of these close attention is being given, and this wide survey must inevitably assist improvement in many branches of crop-production.

The Indore Institute is itself an experiment. Its avowed aim—the application of science to crop-production—is clearly reflected in both general organisation and experimental policy. Some of its features are novel, and some have been pre-determined by the cir-

cumstances of the area it serves. As an agency—the central agency —in the agricultural advancement of Central India, its strong potentialities are already manifest. As a new model it will claim the close interest of all to whom it falls to create or maintain centres of agricultural research.

F. L. ENGLEDOW

AGRICULTURE IN INDIA

Value of Research

The Times, Nov. 14th, 1929

The recent formation of the Council of Agricultural Research in India, as recommended by the Royal Commission on Agriculture under Lord Linlithgow, inaugurates a new and progressive policy for the improvement of crop-production in that country. Some idea of the scope for improvement may be derived from the figures of cultivated area and of average out-turn.

The total of 350,000,000 cultivated acres, of which 290,000,000 are under crops in an average year, includes 80,000,000 acres of rice, 30,000,000 of wheat, and 23,000,000 of cotton. The out-turn on the other hand is low, varying in the case of wheat from 7 to 17 bushels per acre in the several British Provinces. Only nine or ten million acres are under improved crops of any kind, although the increased value of such crops is estimated already at about £9,000,000 per annum. Clearly, therefore, there is room for an almost indefinite expansion of scientific knowledge in the agricultural field.

The Research Council, which is financed by an initial grant of £200,000 and an annual grant of £50,000 from the Indian Government, was intended by the Royal Commission to co-ordinate the activities of all institutes and other bodies, whether under the Central or the Provincial Governments, which are engaged in research work. The Imperial Institutes of Agriculture at Pusa, veterinary science at Muktesar, and animal husbandry at Bangalore have in the past overlapped in certain respects the functions of the provincial agricultural colleges and the agricultural farms and stations. It is not practicable to allocate the duty of research into one subject

or a single crop to a single province or institute, since widely varying local conditions render the conclusions of one area inapplicable to another. The results of intensive research must be subjected to local experiments, and have further to be demonstrated to the highly conservative peasant in the only manner which will convince him—that is, in his own village home.

The Indore Institute

Nor is it advisable to subdivide the field of research merely on "single crop" lines, since fundamental problems, common to all plants, soils, and animals, remain to be solved. On the other hand, the detailed examination of specific crops, particularly if the conditions of preparing the produce for the market and also of marketing are studied *pari passu*, has value both for the producer and for the merchant. The Royal Commission warned the jute traders that only scientific study would free them from the danger of competing fibres, and it is regrettable that concerted action has not been taken by the trade to create the central jute committee which was proposed for this purpose. The Research Council, on the other hand, has without delay formed a sugar sub-committee, which will further the efforts of the Imperial Sugar Bureau at Pusa and the sugar-cane station at Coimbatore.

The most notable instance of single-crop research is that of the Institute of Plant Industry which is carried on at Indore, in Central India, under the enthusiastic direction of Mr. and Mrs. Howard. This foundation, which is supported by numerous Indian States but for finance depends mainly on the Central Cotton Committee, aims at pursuing three parallel lines of investigation into (1) the botanical analysis of the existing cotton species on the black soil of Central India; (2) the breeding of pure and improved varieties which are suitable to this soil; and (3) the agronomy of cotton, including the root development of the plant, the effects of drainage and manurial treatment, and the causes of failure of certain varieties. It has, for instance, been ascertained that Cambodia cotton, which flourishes on irrigated lands, is unsuccessful on rain-watered lands in consequence of its peculiar root system. Agriculturists will recollect a similar explanation of indigo wilt in the United Provinces and Bihar.

The Director of the Institute is confident, as explained in his

publication, "The Application of Science to Crop-production" that the acre yield of raw cotton can, with the help of concentrated and scientific study, be doubled in 20 years, and quotes the success of the Java sugar researches in evidence of his view. He similarly hopes to see out-turns of 40 bushels per acre of Pusa wheat. Optimism in a scientist is a potent stimulant, and the attainment of the suggested results would mean an enhancement of the annual crop value of cotton and wheat in India by £90,000,000 and £240,000,000 respectively. Yet, although theoretically possible, so rapid an advance is barred by the reluctance of the Indian cultivator to alter his traditional methods, and the tendency of the middleman to adopt unwelcome practices.

Propaganda

Cotton of the older short-staple types survives in the Punjab side by side with American long staple, partly because the cultivator's wife prefers the former for domestic use; the up-country merchant seizes the opportunity for a judicious admixture of the shorter and cheaper variety in the centre of a long-staple bale, and the Central Cotton Committee have been confronted by no more serious obstacle in their attempts to organize honest marketing. Such mundane considerations must be borne in mind, and the Royal Commission suggested accordingly that in the area to be irrigated by the new Sind canal, estimated at 5,000,000 acres, the settlers be prohibited by terms of their grant from growing other than a single specified variety of cotton.

The Cotton Committee clearly believe in the value of scientific research, since in addition to their annual grant to the Indore Institute they have decided to spend a sum of £250,000 on propaganda, in order to bring home to the cultivator the definite knowledge already secured. The income of the Committee is drawn from a cess on Indian cotton, and a like charge on jute and sugar-cane would seem equally justifiable. The rubber cess which maintains the Rubber Research Institute in Malaya affords a similar example of scientific endowment. India imports annually from 700,000 to 800,000 tons of foreign sugar, much of which could be replaced if Coimbatore canes were generally adopted in Northern India.

Mere extension of area is not economically effective. Only a scientific inquiry into the causes of low production and an organized system of propaganda through the agricultural departments will

raise the general level of the peasants' out-turn. "Research", said Lord Irwin in an address to the Agricultural Research Council, "offers a sure means of stimulating and widening the agricultural development of the country. As science extends its boundaries, it is only by providing adequate opportunity for co-operation that full value can be given to the patient and persistent endeavour of the true scientific worker".

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION

By A. Howard, C.I.E., M.A., and G. L. C. Howard, M.A.

[Pp. iv+81.] (Oxford: at the University Press, 1929
Price 9*s*. net.)

Science Progress, 25, 1930, p. 152

Twenty years' exploration of the best ways in which botanical science could be most profitably applied to the growth of crops in India led both authors to the conclusion that the dissociation of practical agriculture from the separate sciences connected therewith was by no means ideal, even though both aspects were dealt with in a single research institute. As early as 1919 it was suggested that a separate institute should be founded for the study of crop-production along the broadest lines, the aim being to study the development of the plant as a biological whole. Five years later, in 1924, the project came to fruition, and a Research Institute for Crops was founded at Indore, under the direct control of the Agricultural Adviser, and managed by a Board of Governors representing the Indian Central Cotton Committee, and the States contributing to the finances. Thus the Institute is run on Western lines, as it was erected and is financed entirely by subscriptions, and is controlled by the subscribers. The main objects are to carry on fundamental research on cotton, to train post-graduate students, and to provide an agricultural centre for the States of Central India and Rajputana at which cultivators and officers can be trained.

A suitable site for the Institute was found at Indore, in Central India, which fulfilled certain necessary conditions, as possessing varied types of soil with ample supplies of irrigation water, having

a good supply of labour available, and being near a town to provide easy transport for crops and visitors, and also social amenities for the staff. Much care was devoted to the lay-out of the land, drainage and roads were provided for, and a systematic scheme adopted to bring the fields into order for experimental work. The laboratories and library were carefully planned, and the provision of a small lending library and arrangements for the sale of standard books have proved very popular. The buildings necessary for housing part of the staff have been put up as a model village, and the capital cost of the institute as a whole was £23,538.

Cotton is the chief crop under investigation, the programme including the investigation of fundamental questions applicable to the whole of India, the improvement of varieties grown under dry and irrigated conditions, and general improvements in methods of cultivation. In the latter connection it is emphasised that it is the weight of the cotton fibre produced on every acre of land which is the matter of chief importance, and which is limited by the conditions under which the cotton plant grows. The eradication of perennial weed grasses is of vital importance, in that they always seriously reduce the cotton crop, and in unfavourable years they may spread so rapidly as to prevent the land being cultivated at all.

The control of the monsoon rainfall by an efficient system of surface drainage means a great increase in crop, as from 145 lb. to 510 lb. per acre of cotton and 370 lb. to 1,005 lb. per acre of wheat. Other experiments deal with various means of increasing the nitrogen supply available for crops, the methods used being as simple as possible and within the scope of the ordinary cultivator.

Much scope exists for improvement and extension of well-irrigation, particularly in certain areas where the growth of the wild date (*Phœnix sylvestris* Roxb.) indicates the presence of extensive subterranean water-bearing areas. The methods used at present are defective in many ways, and efforts are being made to persuade cultivators to rectify these errors. Other work of the Institute deals with the improvement of cattle and the sale of implements and machines, a special trading account having been opened for the latter purpose.

Care is taken to maintain a close liaison between the Institute and its supporters. Officers and students are accepted for training. Special meetings of ordinary cultivators are arranged, and general

visitors are encouraged, with the result that already definite progress is being recorded from almost every Contributing State.

The detailed and lucid account of the growth and aims of the Institute concludes with a comprehensive list of papers illustrating the scope of crop-production, and with a copy of the "Memorandum of Association and Rules of the Institute of Plant Industry, Indore."

W. E. BRENCHLEY

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION

By A. & G. L. C. HOWARD. Oxford University Press. London: Humphrey Milford. 9*s*.

Journal of the Royal Society of Arts, 78, 1930, p. 884

The title of this book suggests that a far wider sphere is covered than is actually the case, but the sub-title of "An Experiment carried out at the Institute of Plant Industry, Indore," is more explanatory. The book is, in fact, an account of the inception, organisation and progress during the first five years of the Institute, which was established at Indore in 1924, under the directorship of the author, for the study of cotton-growing problems in Central India. The justification for the title lies in the argument developed throughout the book that the usual method of "organisation of a research institute, on the basis of practical agriculture on the one hand, and of the separate sciences on the other, is by no means the ideal arrangement." It is maintained that the splitting up of the problems into a number of parts, some of which are dealt with by stations created for studying only the practical problems met with in the field, while the others, of a more fundamental nature, are considered to be the province of institutions of pure research, is essentially unsound, and leads only to overlapping and to failure to make the best use of the information discovered. The Institute of Plant Industry at Indore was founded with the idea of studying the crop as a biological whole and of creating improved methods of disseminating the knowledge acquired to the actual growers. The intention is very laudable and the results obtained are undoubtedly excellent, but it is a little difficult to see that the method is so entirely original as is

claimed for it. One need only point to such institutions as the Long Ashton Research Station and many others in England and to the Tea and Rubber Research Institutes in the East, where the study of the crop along these lines is surely as complete.

That cotton-growing in India might be improved enormously is a fact beyond dispute. The acreage under cotton cultivation in India is only one-third less than that in the United States, yet the crop is only one-third as large owing to the very low yields obtained. These low yields are due to a great number of causes, of which one of the most important is the poor methods of agriculture in use, a problem to which the new Institute is devoting a great deal of its attention.

Chapters I and II of the book deal with the foundation of the Institute, the planning of buildings and lay-out of the experimental area. Full details are given for the benefit of workers and administrators in other parts of the Empire. Particular attention has been paid to the grading of the surface of the fields, and to the provision of suitable drainage in order to prevent so far as is possible the loss due to that great enemy of tropical agriculture, soil erosion.

In Chapter III the investigations on improvement of cotton varieties by selection are recounted. Several improved strains suitable for the different areas and methods of cultivation have been obtained, and are eagerly sought after by cultivators. The next two chapters are concerned with improvement in the agronomy of cotton and other general agricultural problems. Considerable advances have been made by the development of a practical and economical method of eradication of one of the greatest weed-pests of Central India, the wild sugar-cane, and by the utilisation and improvement of the Chinese method of preparation of an artificial manure, suitable for the black soils, from waste vegetable produce.

Undoubtedly one of the means by which the Institute will prove of the greatest value is in the facilities provided for a training of all kinds in cotton agronomy. Arrangements are made not only for the training of post-graduate science students, but also for the teaching of workmen and cultivators how to grow their cotton to the best advantage.

An unexplained omission in the programme of investigations cannot pass unnoticed. No reference at all is made to the problem of diseases and pests of cotton, and it is difficult to see why so important a factor should have been left out of account. It is true that India

is fortunate in having less trouble from this source than most other cotton-growing countries, but to mention one disease alone, the widespread "wilt-disease" takes a heavy annual toll in many parts.

R. H. STOUGHTON

COTTON: CULTIVATION IN INDIA

A. & G. L. C. HOWARD. *"Application of Science to Crop-Production,"* 1929, pp. 17-42

The British Cotton Industry Research Association. Summary of Current Literature, 10, 1930, p. 357

The work of the Institute of Plant Industry, Indore, dealing with (1) the investigation of fundamental questions, the results of which apply to the whole of the cotton work in progress in India, (2) genetics, including the improvement of the kinds of cotton now grown in Central India and Rajputana under dry and irrigated conditions, and (3) improvements in the agronomy of cotton, is outlined. Among the results of general interest in the first section are the following—(*a*) The suitability of *roseum* cotton (a variety of *G. neglectum*) for black soils appears to be bound up with a most efficient type of root-system which closely fits the soil type as well as the general moisture conditions. (*b*) The failure of American types like Cambodia, as a rains crop on black soils, is a direct result of a type of root-system suitable only for rich soils or for irrigated conditions. (*c*) The response of the root-system of cotton to improved surface-drainage and to better soil-aeration is very marked, this explaining the results obtained on ridges in Gujerat. In the second section, selected *malvi* cotton (a variety of *G. neglectum*) promises well for growth in Central India and appears to have qualities likely to be of use elsewhere. One of its most striking characteristics is the high proportion of cotton to vegetative growth, and another useful characteristic is its power of resistance to adverse monsoon conditions. Selection work on *roseum* and *bani* (*G. indicum*) is also in progress. Cambodia so far offers most promise for an improved cotton for well-irrigated lands in Central India and Rajputana. The agronomical work has concerned the following factors which

seriously limit the growth and yield of cotton on the black soils. The eradication of perennial grasses, of which *kans* is the most important, the control of the monsoon run-off during the rains, the lack of sufficient permeability during the second half of the monsoon, due to the excessive development of soil colloids, and the low content of organic matter in the soils.

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION

By A. & G. L. C. HOWARD. Published by Humphrey Milford, Oxford University Press, Amen House, Warwick Square, London, E.C. 4. (82 pp., price 9*s*.)

The Journal of the Textile Institute, 21, 1930, p. P16

This is the record of an experiment carried out at the Institute of Plant Industry, Indore. In Chapter I is described the origin of the Indore Institute as a natural sequel to that at Pusa, together with the history of the gradual carrying out of the idea of having a central institution for the study of actual crop-production, with less fragmentation of the factors therein concerned among the various ancillary sciences. The plant yielding the crop must be studied in relation to the soil, the conditions of village agriculture, the economic uses, etc. Chapter II goes on to describe the Institute itself, and its lay-out ; it covers 300 acres. Chapter III deals with investigations on cotton, which form the chief line of work, as the place owes its origin to the grants made by the Indian Central Cotton Committee. The programme falls into three groups—(1) The investigation of fundamental questions ; the results of which apply to the whole of the cotton work in progress in India. (2) Genetics, including the improvement of the kinds of cotton now grown in Central India and Rajputana under dry and irrigated conditions. (3) Improvements in the agronomy of cotton. A collection of unit species is in process of formation, and a careful study of their root systems has already led to the explanation of facts hitherto not properly understood in the success or failure of cotton under various conditions. A preliminary survey of the root-systems of the Indian cottons had been made, with a view to discovering the general differences in type, and the effect of factors like soil-aeration or water-

logging upon root development. This work already seems to indicate the reasons for the success of *roseum* cottons and failure of Americans on black cotton soils. Variety improvement also is well under way. Chapter IV deals with improvements in the agronomy of cotton. It is considered that so far as is necessarily the case in introducing improvement among a naturally conservative agricultural population, the line of least resistance—the introduction of obvious improvements like better varieties—has been taken, but that now other things may begin to receive attention, future work being a well-balanced combination of agronomy and genetics with soil science. An account is then given of the various factors limiting production upon black soil, and the measures that can be taken. Such factors are the growth of perennial grasses and soil erosion, in which matters the work done is of particular interest at the present time. Chapter V discusses further agricultural improvements, such as in well-irrigation, cattle, implements, machinery, etc. Chapter VI deals with liaison between the Institute and its supporters. In Chapter VII the important subject of the organisation of agricultural research is dealt with, this article forming a very important contribution to the subject from two workers who have themselves done brilliant work. The difficulties involved in the present system of "long range" and "local" research stations are pointed out, and a division into "research" and "demonstration" stations is suggested as preferable. It is upon this conception that Indore is being organised. "Better men are needed, not more machinery," is the summing up; "the man is everything, the organisation a minor matter." No one interested in agricultural progress should leave this book unread.

J. C. W.

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION

By Albert Howard, C.I.E., M.A., and Gabrielle L. C. Howard, M.A., published by Humphrey Milford, the Oxford University Press, at 9*s*. net

International Cotton Bulletin, 8, 1929, p. 246

This book is the result of the writers' 20 energetic years' activities in India, engaged in exploring the directions in which

botanical science can profitably be applied to the crops of that country. The organization of an Agricultural Research Institute was undertaken by the authors in 1919 at Indore. The general objects and the lines of work are: (*a*) The establishment of an Agricultural Research Institute for the Indian Central Cotton Committee at which fundamental investigations on cotton can be undertaken. In addition a critical study of cotton growing on the black soils of India, and the production of improved cottons for Central India and Rajputana, both for dry and for irrigated conditions, will be undertaken. (*b*) The training of post-graduate students nominated by the Central Cotton Committee. (*c*) The provision of an agricultural centre for the States of Central India and Rajputana, which will serve as an object lesson for the development of this portion of India, and at which officers and cultivators, nominated by the Darbars, can be trained. The authors describe minutely the arrangement of the buildings and the working of the organization.

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION. An experiment carried out at the Institute of Plant Industry, Indore. By A. and G. L. C. Howard. (Humphrey Milford, Oxford University Press, B.I. Building, Nicol Road, Bombay, 1929. Price 9*s*.)

The Empire Cotton Growing Review, 7, 1930, p. 51

In Chapter I is described the origin of the Indore Institute as a natural sequel to that at Pusa, together with the history of the gradual carrying out of the idea of having a central institution for the study of actual crop-production, with less fragmentation of the factors therein concerned among the various ancillary sciences. The plant yielding the crop must be studied in relation to the soil, the conditions of village agriculture, the economic uses, etc. Chapter II goes on to describe the institute itself, and its lay-out; it covers 300 acres.

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A collection of unit species is in process of formation and a careful study of their root-systems has already led to the explanation of facts hitherto not properly understood in the success or failure of cotton under various conditions. A preliminary survey of the root-systems of the Indian cottons has been made, with a view to discovering the general differences in type, and the effect of factors like soil-aeration or water-logging upon root development. This work already seems to indicate the reasons for the success of roseum cottons and failure of Americans on black cotton soils. Variety improvement also is well under way.

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In Chapter VII the important subject of the organization of agricultural research is dealt with, this article forming a very important contribution to the subject (at present under consideration in our pages) from two workers who have themselves done brilliant work. The difficulties involved in the present system of "long range" and "local" research stations are pointed out, and a division into "research" and "demonstration" stations is suggested as preferable. It is upon this conception that Indore is being organized. "Better men are needed, not more machinery" is the summing up ; "the man is everything, the organization a minor matter." No one interested in agricultural progress should leave this book unread.

SCIENCE AND CROP-PRODUCTION

Capital, 83, 1929, pp. 1247 and 1308

Twenty years ago, consideration of the vast problems of the improvement of Indian agriculture was almost exclusively confined to a small band of enthusiastic scientific workers, the pioneers of the present Indian Agricultural Service. To-day, these problems are rightly considered matters of national importance and more and more attention, both non-official and official, is being focussed on their solution. The work done in the past will bear comparison with the history of agricultural improvement in any part of the world, but it must be admitted that a "national awakening" in the direction of better agriculture is still a vision of the future. With very few exceptions, the improvements in materials and methods, so thoroughly and laboriously worked out on experimental farms and in laboratories, have had but little effect on general agricultural practice. On the great black soil tracts of Central India, the stunted and ill-nourished cotton plants continue to produce a paltry hundred pounds of lint per acre. In the Deccan, the yield of bajri is fully less than one-half of the possible production of that crop under good farming methods. India, with nearly half the sugar-cane acreage of the world, has still to import sugar for her internal requirements. The research worker and the ryot have not yet succeeded in "getting together".

In the past, the necessity of attracting the attention of the cultivator by some immediately striking and simple improvement in the yield or quality of his crops has undoubtedly influenced the trend of work of scientific investigators in agriculture in India. The results of the replacement of a variety, of the distribution of improved seed, of measures designed to check insect or fungoid attacks are easily demonstrable and make good reading in departmental reports. But there is very serious doubt whether such work alone, important though it may be can ever result in any permanent improvement in the agriculture of the country. Without belittling in any way the great services which have been rendered to India by the labours of devoted experts in specialised branches of agricultural science, it now seems obvious that such labours cannot bring any lasting profit to the cultivator unless preceded by the widespread

establishment of better agricultural conditions. What is definitely required is a general advance in the direction of better farming methods, in the management of the land and of the crops grown thereon, in short in better agriculture and the application of science and common sense to crop-production.

We believe that it is possible, within the next twenty years, to achieve such an advance and to bring about what will be, in fact, a revolution in agricultural practice in India. But old and effete organisations and methods must be discarded, obsolete and over-strained systems must be replaced and the problems of agricultural improvement must be regarded from a fresh standpoint and with new vision. In the first place, nothing is so important as the actual growing of the crop so as to produce the highest possible return to the cultivator for the labour expended. Therefore, in the future, the science of agronomy must receive primary consideration from research workers in India. The botanist, the entomologist, the mycologist and the chemist must, first and foremost, be agriculturists and the water-tight compartments into which these experts have been forced under an out-of-date organisation must be entirely abolished. Then and then only, will the results of specialised research, imprinted upon a general uplift of the standard of agricultural practice in the fields and villages, render a full return to the country.

Secondly, the all-important work of demonstration and propaganda—so long the Cinderella of the Agricultural Departments in India—must be raised to an equal co-partnership with the work of scientific research. More brains and more money must be expended on the essential business of reaching the cultivator and of "delivering the goods" in the villages and homesteads. The vast potentiality of non-official aid in this work must be explored and developed to the utmost. Also the "goods for sale" must correspond with the actual requirements of the "customers" and the prices must suit their pockets. The vast majority of the cultivators of India are prepared to deal at a "Woolworths" whereas a "Harrods" has no appeal. The best and most urgently required improvements in Indian agriculture are the cheapest and it is no exaggeration to state that the return of most of the main crops of India could be increased at least 30 per cent. by the adoption of better farming methods alone and by the utilisation of a small portion of the ryots' spare time without the expenditure of one single rupee of additional capital.

The organisation of agricultural research on the lines mentioned

above and the harmonious co-ordination of scientific investigation and popular demonstration has been accomplished with no small measure of success at the Institute of Plant Industry, Indore. The history of the Institute, the work in progress there, and methods employed and the results achieved in the short space of five years are set forth in a most interesting and comprehensive manner in a recent publication, "The Application of Science to Crop-Production" (Oxford University Press), by Mr. A. Howard, C.I.E., M.A., Director of the Institute, and Mrs. G. L. C. Howard, M.A., Second Imperial Economic Botanist (on deputation to the Institute). The world-wide reputation of the authors in agricultural science lends considerable authority to this account of what is modestly termed "an experiment carried out at the Institute of Plant Industry, Indore", but this record of the building up and development of a large Central Research Institute for the improvement of agriculture will be widely read on its own merits as a most valuable contribution to the progress of agricultural research and rural development within the British Empire.

The Institute of Plant Industry, Indore, was established in 1924, in which year the Indian Central Cotton Committee agreed to furnish the capital cost of the buildings and to provide a large share of the annual expenditure. In this way, there was started that intimate relation between the work of the Institute and the activities of the Central Cotton Committee which is having so beneficial and stimulating an effect on the improvement of cotton-growing in Central India. In the original scheme for the establishment of a Central Research Institute in Central India, the value of such an institution as a centre of agricultural development in the important neighbouring Indian States was fully realised and, when the Institute was formed, eight of the original contributing States—Indore, Datia, Dhar, Dewas (Senior Branch), Jaora, Rutlam, Sitamau, and Narsingarh—agreed to come into the revised scheme and to contribute annually to the working expenses of the Institute. Since 1924, five other Indian States, viz., Tonk, Bijawar, Barwani, Jhalawar, and Bikaner, have joined the scheme and are utilising fully the assistance of the Institute and its staff in the agricultural development of their territories. The first two chapters of Mr. and Mrs. Howard's book give a useful and detailed account of the history and development of the Institute during the past five years. The sections dealing with the selection of the site, the lay-out of the

area and the construction and cost of the farm buildings and laboratories are particularly valuable and cannot fail to be of very practical utility to all research workers and administrators. The suggestion might be offered to the newly-formed Executive Council of the Imperial Research Bureaux that the collection and publication of similar information with regard to all the Agricultural Research Institutes in the Empire would be a work of extreme value and would supply a definite want in agricultural literature.

In view of the close association between the Indian Central Cotton Committee and the Institute of Plant Industry, it is not surprising to find that investigations on the cotton crop occupy a major place in the work of the Institute. These investigations comprise research into fundamental problems of cotton-growing, the results of which will apply to cotton-growing all over India, genetics, including the improvement of the cotton crop in Central India and Rajputana and the improvement of the agronomy of cotton. Chapters III and IV of Mr. and Mrs. Howard's publication are entirely devoted to an account of this work and give a record of the progress made up to the current year. The results obtained from the detailed study of the root-systems of different species of cotton, when grown under dry or irrigated conditions on the black soils, are of fundamental importance and indicate a line of investigation in plant-breeding to which insufficient attention has been given in the past. Progress has been made in research on another basic problem: the effect of environmental conditions, *e.g.*, adverse soil conditions on the susceptibility of the cotton plant to disease and insect attack. The evidence already obtained in this connection emphasises the necessity of entomological and mycological research being conducted, not as a separate branch of agricultural science, but in close co-ordination with general agronomic investigations. The cotton trade in general will note with interest that the baffling variations in the quality of the commercial crop which are met with from year to year form another subject under examination at the Institute and that a search is being made for practical methods for improving the uniformity of the fibre in any cotton.

Possibly the most valuable investigations so far carried out at the Institute of Plant Industry deal with improvements in the agronomy of cotton devised to secure a greatly increased output of seed cotton per acre. The results of this work are described in

Chapter IV of Mr. and Mrs. Howard's book and the authors are to be congratulated on the simple but effective measures which they have evolved to check the factors limiting the production of cotton on the black soils and to get the best return from the land. As is well known, the produce of an average cultivator's cotton field in Central India is obtained from dwarfed and sickly looking plants, competing for existence on an impoverished soil with a luxuriant growth of perennial weeds and subject to the threat of complete destruction by drought or excessive rainfall according to the vagaries of the season. Mr. and Mrs. Howard have definitely shown that such a state of affairs is not irremediable and that, by the adoption of simple and cheap agricultural methods, the acre yield of cotton in these areas can be more than doubled and, even in unfavourable seasons, profitable returns obtained. The eradication of perennial weeds by means of timely ploughings with a cheap ploughing outfit devised at the Institute, the control of the monsoon rainfall by an efficient but simple method of levelling, grading and surface drainage, the utilization of vegetable refuse to prepare compost for the supply of the essential organic matter as crop food in the soil are the main remedies tried, tested, and advocated by the authors for the improvement of cotton cultivation in Central India. All these remedies could be put into effect by a village community at a cost certainly not exceeding Rs. 200 and, as has already been shown at the Institute, the return would be an increased yield of at least 100 per cent. on the village cotton fields. The urgent necessity is continued demonstration and propaganda to establish such methods of agriculture. General practice is therefore clearly apparent and, in the interests of rural India, vitally important. Once these methods have been established, the work of the plant-breeder, mycologist, entomologist and similar specialized experts can be superimposed as a coping stone on a building whose foundations are securely based on the solid rock of good agriculture.

In the next chapter of their book, the Howards deal with further agricultural improvements to which attention is being paid at the Institute and which chiefly relate to the problems of Central India and Rajputana. The improvement of cultivation on well-irrigation—so important to many of the Central India and Rajputana States—is considered in detail under sections dealing with the improvement of existing wells and the application of water to the land by the most economical and profitable methods. The im-

provement of cattle forms the subject of another interesting section of this chapter in which a valuable account of silage-making with juar, as practised at the Institute, is given. It is encouraging to read that, as a result of the work of the Institute, a growing public demand for the implements and appliances in use there has sprung up and accordingly, a separate trading section has been organised to supply such articles to purchasers. The rapidity with which this development of the work of the Institute has taken place is a striking testimony to the system by which the work of the Institute has been brought to the notice of the zamindars and to the readiness of the cultivators to adopt simple and practical improvements.

As stated in a previous paragraph, the funds for carrying on the work of the Institute of Plant Industry are provided by an annual grant from the Indian Central Cotton Committee and by annual contributions from certain Indian States in Central India and Rajputana. It is therefore essential that the Institute should maintain a close relation with its subscribers. In Appendix B to Mr. and Mrs. Howard's book will be found the "Memorandum of Association and Rules of the Institute of Plant Industry, Indore," in which the composition of the Governing Body is described. The Chairman of the Governing Body is the Hon'ble the Agent to the Governor-General in Central India and of the six members three represent the Indian Central Cotton Committee, one the Holkar State and two the other "Contributing States to the Institute." This system of management has proved most satisfactory as all the subscribing bodies are represented on the Governing Body and have therefore a direct connection with the administration and management of the Institute. As might be expected, the Institute affords excellent facilities for training and these facilities are taken full advantage of by the Central Cotton Committee and the Contributing States. Nine of the Committee's post-graduate research scholars have completed their training at Indore and the Contributing States are sending increasing numbers of officers and students for instructional courses in improved agriculture.

As the usefulness of the Institute will be largely judged by the influence it exerts on the local agricultural practice and by the extension of the practical results obtained in the neighbouring Indian States, special measures have been adopted to link up the work of the Institute and the cultivator. The labour force of the Institute is regarded as a training ground and every year a number

of trained workmen, skilled by experience in the best agricultural methods, are exported to the various States where they demonstrate in the villages the improvements which they have learnt at the Institute. Also annual cultivators' meetings are held which are largely attended by selected villagers from the States to whom the various improvements in operation at the Institute are demonstrated and explained.

In their last chapter, "The organisation of Agricultural research," Mr. and Mrs. Howard discuss briefly the relations existing between central and local research institutes and the arbitrary distinction which has developed in the nature of the research work carried out at these two types of experimental stations. This subject was considered in much detail by the recent Royal Commission on Agriculture in India who considered it one of the most important problems with which they were confronted. The Commission were convinced that there was a decided lack of sufficiently close touch, not only between central and local research institutions and workers, but also between the research organisations in the different provinces of India. The measures advocated by the Commission—and now largely adopted by the Government of India—to secure a higher degree of co-operation and co-ordination in agricultural research are fresh in the minds of everyone. It is sincerely to be hoped that they will prove successful and that research workers all over India will come to "regard themselves as partners in the same enterprise." But to quote again from the Commission's Report: "Agricultural research can be of no help to the cultivator until its results are given to him in a form in which they may become a part of his agricultural practice." We therefore cordially agree with the Howards that the problems of agricultural improvement and rural reconstruction in India must be attacked in two waves, the forces of research and scientific experimentation overcoming obstacles and gaining new ground with equally strong and well-equipped forces of demonstration and propaganda following immediately behind to consolidate and maintain the advances made. In accordance with this conception, the work of the Institute of Plant Industry, Indore, has been planned and carried out and the record of progress made is a more than ample justification for the organisation and system adopted.

In conclusion, it may be mentioned that, in pursuance of the policy of maintaining the closest contact between the Institute and its supporters, the last meeting of the Indian Central Cotton Com-

mittee was held at the Institute early in November, 1929. In this way, all the members of the Committee were given the opportunity of seeing the work in progress at the Institute and of acquiring a personal knowledge of the agricultural improvements in operation there. At the opening session of the Committee's meeting, which was attended by the Hon'ble the Agent to the Governor-General in Central India and numerous representatives of the Contributing States, the interesting and important announcement was made that Sir Sarupchand Hukumchand, Kt., one of the merchant princes of Indore, proposed to start a three hundred-acre seed farm for the production and extension of the improved Malvi cotton seed evolved at the Institute. This generous proposal had been agreed to by His Highness the Holkar's Government and the seed farm, incorporating all the agricultural improvements worked out at the Institute, will soon be an accomplished fact. If similarly, in other parts of India, the efforts of the scientific research workers and the agencies for demonstration and propaganda in the villages can be supplemented in the work of rural reconstruction by the active support of the non-official and commercial communities, the regeneration of Indian agriculture by the application of science to crop production will be assured.

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION

By Albert Howard, C.I.E., M.A., and Gabrielle L. C. Howard, M.A. Oxford University Press. Price Rs. 6

Capital, 84, 1930, p. 1454

In this book the authors record the result of an experiment carried out at the Institute of Plant Industry, Indore—an experiment which demonstrates how science can be pressed into the service of agriculture to make two blades of corn grow where one used to grow before. The details are highly interesting and show how at each step scientific agriculture, under expert and skilful guidance, has been made to yield results which are in a sense of world-wide importance. In India their value is unique. The history of the Institute of Plant Industry, Indore, is the history of the growth of an important agricultural institution under the fostering care of the

authors supplemented by pecuniary aid generously given not only by the Indore State but also by the other neighbouring States—a happy combination of circumstances which has so materially contributed to the success of the Institute. The book reads like an agricultural romance from the first chapter dealing with the genesis of the Indore Experiment to the last detailing the organisation of agricultural research. It should interest agriculturists and non-agriculturists alike and in an agricultural country like India it should be widely read. And that it may be widely read its translation into the several Indian vernaculars cannot be undertaken a moment too soon. It is a book of abiding interest—a book pre-eminently for the masses showing how the agricultural industry can be best exploited.

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION

By Albert Howard, C.I.E., M.A., and Gabrielle L. C Howard, M.A. Pp. vi+81 ; illustrated. (Oxford University Press.) Price, Rs. 6

The Agricultural Journal of India, 25, 1930, p. 175

For quarter of a century, the talented authors of this book have laboured, in a happy and fruitful partnership, to advance scientific research in agriculture and by their contributions, important both to the science and the craft of agriculture, have won for themselves a front rank position among research workers of the British Empire. Unknown to the Indian cultivator, they have, by their thinking and experimenting, carried abundance and hopefulness to the mud hamlet of the peasant. Their literary output is large, being contained in one hundred and twenty-nine publications, chiefly papers on the problems of agriculture. Some of the books are well known to the specialist as well as the layman.

In the book which forms the subject of this review, the authors present the reader with an interesting account of the Institute of Plant Industry at Indore and make observations on the organization of agricultural research. The Institute deserves to be more widely known, and it is to be hoped that this publication will serve the purpose of creating an interest in and enthusiasm for its activities, one noteworthy of which is the interesting innovation of linking the farmer to the magic-house of science by means of demonstrations at the Institute.

At present the Institute is chiefly concerned with the improvement of cotton, suitable for the soils of Central India. Taking into consideration the fact that agriculture rests on a number of sciences, it does not appear from the list of the staff given on page 16 that all of these sciences have found a niche in the Institute. The Director and his capable second-in-command are able, however, to overcome such deficiencies.

The authors' views on the rôle of the research worker, his habitat and the surroundings most congenial to him are in harmony with the ideas of the Royal Commission on Agriculture.

In the statement that "in research the man is everything and the organization a minor matter," emphasis is rightly laid on the principal factor, the deficiencies of which cannot be made good by brick and mortar, collection of costly apparatus and elaboration of systems of organization.

Their criticism, however, of the present organization of agricultural research work as obsolete in character is rather sweeping. It does not take into account the difficulties of the situation. The sciences which cluster round agriculture are progressing rapidly. No one individual, unless it be a master mind, can be at home in each one of these sciences. Separation is thus a matter of necessity. Given the spirit of team work and single-minded devotion to an ideal pervading the corps of workers in an institute, the balance of advantage is decidedly in favour of organization by sections. [L.K.H.]

Scientific Agriculture

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION

By A. & G. L. C. HOWARD. (Oxford University Press)

The Leader, Dec. 23rd, 1929

The authors of this booklet are not strangers to those who are interested in Indian agriculture. For the last twenty years these two distinguished workers have been engaged in exploring the avenues in which botanical science could profitably be applied to the crops of India ; and the results of their investigations have been published from time to time in important journals and in the form of monographs. Two other books by the same authors, 'Crop Production in India' and 'The Development of Indian Agriculture' need mention.

In this booklet the authors give a detailed account of the Institute of Plant Industry, Indore, and its activities. The Institute is run with the help of the contributions received from the Indian Central Cotton Committee and some of the ruling princes of Central India. An important feature of the Institute is the thoroughly practical character of the investigations carried on in the Institute. For many years in the past, agricultural research in India has unfortunately been divorced from the actual realities and conditions prevailing in rural India. We are glad to note that the Institute has decided to use no power on the farm which could not be commanded by an ordinary well-to-do Indian cultivator. Tractors, steam threshers, and electrically-driven pumps are avoided. The use of implements which are not beyond the means of the Indian cultivators is likely to make the Institute popular with the cultivators. Another novel feature of the Institute is the training of farmers who, on receiving the instruction there, are expected to cultivate their own lands according to the new methods.

We congratulate H. H. the Nawab of Jaora on his founding a Glancy Scholarship for the training of the sons of cultivators. Much of the energy of the Institute is directed to cotton-growing in Central India, but we are glad to learn that attention is also paid to a much neglected but perhaps the most important side of the problem ; that is, to a study of the agronomic and soil factors involved in cultivation. It appears that the Institute has become an important research and training centre in applied botany and agriculture in our country.

In conclusion, we are constrained to add that the title of the booklet is too ambitious for the subject treated under it and the price prohibitive.

THE PLANT INDUSTRY INSTITUTE IN INDORE

United India and Indian States, Nov. 30th, 1929

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION gives an account of the history and the organization of the Institute of Plant Industry in Indore and incidentally of the agricultural improvements in some of the Central Indian States due to the impetus received from this Institute. The authors worked for

a number of years at Pusa, where the problems presented in the improvement of a crop had to be split up into a number of parts. To avoid that fragmentation, it was necessary to found this new Institute for crops, at which the development of the plant could be studied as a biological whole and not piecemeal. A peculiar feature of this research Centre at Indore has been thus described:

"It has been a frequent reproach in India and other parts of the tropical possessions of the Empire that most of the agricultural research work in the past has been carried out in government institutions by official agency. In Western countries, such work is organized on quite different lines. Most of the research centres are autonomous bodies financed, in part at least, by benefactions of various kinds. This arrangement not only affords ample scope for rapid development but also tends to make the bond between the research workers and the actual cultivator much closer and more intimate. Further, it helps to remove the work of rural development from the sphere of political discussion. The Institute of Plant Industry at Indore was erected and is financed entirely by subscriptions and is controlled by the subscribers. Moreover, it furnishes an example of the union of diverse interests for a common purpose."

Among the subscribers to this Institute the most notable are the Indian Central Cotton Committee and the Bikaner and Indore Darbars. The Institute serves the Central Cotton Committee as a centre for fundamental investigations on cotton and for the training of post-graduate students by the Committee. It also serves as an agricultural centre for the States of Central India and Rajputana. Investigations on cotton naturally take up a great deal of the energies of its staff. As very little has been done during the last twenty years on the study of cotton growing and on the various agronomic and soil factors involved, it has been decided to make cotton agronomy one of the important subjects of research at this Institute.

"The work will be greatly assisted by a generous donation from one of the merchant princes of India—Sir Sarupchandji Hukamchand—who has been so impressed with this aspect of the subject and with the results already obtained at the Institute that he has very generously founded an All-India studentship of the value of Rs. 150 per month."

The investigations on cotton carried so far show that the fertility of the black soils of India can be doubled by methods well within the means of the cultivator. Efforts will now be made by demons-

tration and publicity, to interest the rural development departments of the various States of Central India and Rajputana in these developments. The Institute has also paid attention to the improvement of well-irrigation, to the cattle problems of Central India and Rajputana and to the introduction of simple implements and machines. It is satisfactory to note that the States contributing towards the maintenance of the Institute are now sending an increasing number of officers and students for training and in almost every one of those States definite progress can be recorded in rural development. Indore has by founding a Development Department mobilized its resources for the reconstruction of the country-side: one of the beneficial activities of this Department is the opening of a farm of its own for the improvement of the Malvi breed of cattle. A new experimental farm is being started by H. H. the Maharaja of Bikaner on the new Gang Canal, for dealing with the local problems presented in the best use of the available supply of Canal water. In Jaipur, a large cattle and demonstration farm is being started at Basi and work among the cultivators is in progress. In two of the Central India States, agricultural schools are being opened in connection with the new demonstration farms, a feature which is likely to spread. "In a single generation it is more than probable that some at least of the contributing States will reconstruct their villages, and incidentally double their land revenue."

The Institute has thus come to be recognized as an important research and training centre, which exports ideas and information on rural reconstruction as well as improved varieties of crops and new methods of cultivation. This account of the organization and work of the Institute is to be particularly valued because of the paucity of such literature on the various experimental stations in the British Empire.

A NEW EXPERIMENT STATION IN INDIA

The Statesman, November, 1929

Mr. and Mrs. Howard need no introduction to readers, and they have added to their services to India by *The Application of Science to Crop-Production* (Oxford University Press. Rs. 6), which is a detailed account of the organization of and the work done at the

Institute of Plant Industry at Indore since its foundation five years ago. The chief problem before them was the discovery of the conditions of well-being for the cotton plant, but this evidently meant a wide study of a variety of other matters besides the plant itself, the soil and the rainfall. The ways of human beings were involved, and of cattle, and of weeds. Further, these two gifted friends of India were called on once again to consider what they had considered often before, the ways of getting the best value out of a plant-breeding station. The book, a specialized study for the investigator and agriculturist, is also a contribution in the humanities for the general reader who is not an expert, for man has to be managed and induced to do what is wanted of him no less than the cotton plant. The book, it should be added, is written with splendid clarity, and the layman can follow every step with adequate understanding for his needs.

We cannot summarize the experience, for the book with its seven chapters and many plates is that summary. A few facts only can be abstracted. It is impossible to replace the cotton of the low country by an improved type. Can satisfactory types of cotton be found that will suit both dry and wet lands? What matters is not so much the improvement of the plant itself as the securing of conditions that will produce the greatest weight of cotton fibre per acre. By improving the agronomy of cotton in the black soils the increase may be doubled, whereas by merely improving the variety the increase may be only ten per cent. The best results therefore will be produced by combining agronomy and genetics with soil science, for in wet years some grasses, especially *kans*, flourish on the black soils to such an extent that for many years the fields go out of cultivation altogether. To cope with this weed an eradicating outfit has been devised, which is made for the Institute and sold by it to peasants. Tractor or steam plough was out of the question, as the use of such costly implements would effectively prevent the Institute from having any influence with the cultivator. It is not necessary to show the cultivator that manuring gives good results. He knows it. What he does not know is where to get the manure. So the Institute is teaching him how to make compost out of all kinds of vegetable waste, and by this means give the land the nitrogen it needs. Education was necessary also in watering, levelling, drainage, cattle improvement; when the investigators had found out what was best in the conditions of Central India they set to work to de-

vise methods of spreading the news, which they do by training workers of different kinds for different kinds of responsibility, as well as by attracting visitors. About the utility of agricultural shows the Howards are doubtful ; they are expensive and time-consuming, and bewilder the simple cultivator by their distractions and amusements. But the Institute has its cultivators' meetings, when the villagers come and stay in serais so as to see everything leisurely. A development in response to demand has been the sale of standard books on Agriculture in English, Hindi, and Urdu. The Institute has found many friends, and it is no excessive inference that all selected to establish and develop it are enjoying their experiences.

THE APPLICATION OF SCIENCE TO CROP-PRODUCTION

By Albert Howard & Gabrielle L. C. Howard

Oxford University Press. Rs. 6

The Tropical Agriculturist, 73, 1929, p. 317

Mr. and Mrs. Howard have written an excellent book which can profitably be read by those interested in the formation or direction of an agricultural research institute, by all concerned with tropical agriculture, particularly that of the more arid regions, and lastly by those administrators and officers in the Colonies and Dominions affected by the proposed chain of imperial research stations. Its appeal, therefore, is wide and is of more than normal interest to Ceylon where there are established or are being established tea, rubber and coconut research institutions ; where dry-zone farming is becoming increasingly important and where the establishment of an imperial agricultural research station has been mooted.

The Application of Science to Crop-Production falls naturally into three divisions. The first deals with the genesis of what the authors call the Indore experiment—the experiment of applying science to crop-production which is being carried out at the Institute of Plant Industry in the Central India State of Indore. The second describes the investigations on cotton and on general agricultural problems which are either being carried out at present or are proposed to be carried out, together with an account of some results

already obtained ; and the third division discusses the organization of agricultural research.

Outside India the Indore Institute has been little more than a name and this account of its formation and rôle is welcome. Briefly, the Institute serves as a research station for the Indian Central Cotton Committee and as a central station for the "agricultural development of the territories of the princes and chiefs under the suzerainty of His Majesty." The director of the Institute, Mr. A. Howard, C.I.E., is also Agricultural Adviser to States in Central India and Rajputana. The Institute is financed by the Indian Central Cotton Committee and by the contributing States. Chapter 2 is devoted to describing the establishment of the Institute. Plans of the laboratories and farm buildings are given, together with a statement of capital and recurring expenditure. Detailed accounts of agricultural institutes have seldom been published, and there is no doubt, as the authors hope, that a statement of the considerations underlying the choice of site of an institute for the study of crop-production as well as the details relating to the lay-out, the equipment, and the cost will prove to be of use to workers and administrators in other parts of the Empire.

The competence of the Howards to investigate the means of applying science to crop-production is unquestioned—their investigations in India commenced in 1905 and a list of 128 of their published papers is given as an appendix to this book—and their general policy in crop improvement deserves serious consideration. They write: *"The centre of the subject of crop-production must always be the plant itself, which obviously can only be effectively studied in relation to the soil in which it grows, to the conditions of village agriculture under which it is cultivated and with reference to the economic uses of the product."* The italics are the reviewer's. As the authors say, the organization of an agricultural research institute on the basis of practical agriculture on the one hand and of the separate sciences on the other is by no means an ideal arrangement. "In exploring the problems of crop-production on these lines from 1905 to 1924 the obsolete character of the present organization of agricultural research in India became apparent. The need for the broadening of the subject, as well as for the development of new methods and new lines of attack, became more and more insistent. The only practical solution of the difficulty appeared to lie in making crop-production one of the main sections of agri-

cultural research work in India, and in abandoning the present fragmentation of the subject altogether. As it is not easy to change any form of organization from within, this involved the foundation of a new Institute for crops, at which the development of the plant could be studied as a biological whole and not piecemeal" (page 1). Again on page 27, in discussing cotton it is stated *"the cotton work of the future must be a well-balanced combination of agronomy and genetics with soil science."* The wider use of the word "agronomy" by British workers implies, it is hoped, a wider recognition that agronomy is an important branch of agricultural science. It is interesting to remember here that the staff of the research stations in the Netherlands Indies contains a number of "agriculturists" or what would be known as "agronomists" in North America. The question cannot be discussed at length here, but it is a question that demands careful consideration.

The second division of the book comprises chapters 3 to 5 dealing with investigation on cotton and the agronomy of cotton, with well-irrigation, with improvement of cattle and with the sale of implements. All these are of interest to Ceylon and the method of turning crop residues into an organic compost for manuring succeeding crops is noteworthy. Experiments with the use of juar (sorghum) silage might profitably be repeated in Ceylon.

The final chapter of the book, "The Organization of Agricultural Research," merits very careful study. In discussing the present system of agricultural research stations and of the proposed imperial research stations dealing with fundamental research, the Howards ask: "Is this system the ideal one and are two kinds of research stations necessary? Is the problem based on the merits of the case or does it arise from accidents of administration or from failure to realize what successful research work in agriculture entails in the way of staff and facilities?" To be of economic value results obtained by research stations must be taken into village practice and this can only be done through the agency of local Agricultural Departments. The difficulties of the relationship of research stations to the local Department are discussed. Whatever views may be held as to the value of central research stations there can be little doubt that the conclusions of the authors will be generally approved when they say: "The ideal system of conducting agricultural research in the Empire seems to lie in the simplification rather than in the elaboration of the organization. All that is necessary ap-

pears to be to provide each region with a research institute of its own, to do everything possible to increase the efficiency of these centres and to allow the workers every facility for unofficial consultation and discussion, such as is provided by the meetings of the British Association, the Indian Science Congress and similar bodies. Better men are needed, not more machinery. Any funds that can be provided in the future for agricultural research should be devoted to the payment of competent investigators and to the provision of the means necessary for these men to work out their ideas. In other words, agricultural research must be made a profession. Until this is done, no real progress is possible. Any attempt to overstrain systems of organization in the hope that they may replace competent investigators can only end in failure. In research, the man is everything ; the organization is a minor matter."—*L.L.*

III. CONCLUSIONS

The favourable reception which the first quinquennial review of the work of the Institute has received suggests that the time has come to consider what is the best form in which the results obtained at the various research centres of the Empire should be presented to the public and to the scientific world. This matter has recently been referred to in the leading article of *Nature* of December 13th, 1930, as follows:—

Central Research Stations in Tropical Agriculture

* * * * *

"A critical study of the Amani reports discloses one administrative weakness which is of considerable interest both to the scientific worker and also to the general public, namely, the incompatibility of long-range and wide-range research with the preparation of a detailed annual report. So little progress can be made in such work in twelve months that the submission of an annual report is almost ridiculous. Further, the practice leads to the waste of much valuable time, and also exposes the workers to the risk of uninformed comment and to undeserved criticism. It would seem that an important improvement in administration could be made, and that a reform long overdue could be carried out, if these annual reports could be abolished altogether so far as research is concerned. If the workers at Amani could be asked to furnish instead a well-thought-out quinquennial review in which the purpose, equipment, progress, and cost of the station could be set out in clear and definite form, the present annual reports could be replaced by a brief account of important administrative events, to which a statement of the annual receipts and expenditure, with the usual auditor's certificate, could be attached. This would provide for any necessary administrative control of the station.

From the point of view of the scientific investigator such an innovation has obvious advantages. The workers overseas would then receive adequate protection, and they would be able to work out their own salvation under conditions approximating to those obtaining in the research centres of Great Britain. The growing volume of annual reports, now such an alarming feature of agricultural research in the Empire, would be replaced by the five-yearly

review, which would soon find a permanent place in the literature of the subject. Further, such reviews would provide an effective documentation both for the Press and for the general public interested in the work, and would also prove invaluable as a basis for the deliberations of the Imperial Agricultural Research Conference, the next meeting of which will take place in Australia in 1932. A beginning in the direction indicated might be made next year. If quinquennial reviews of the various experiment stations in Australia and New Zealand for the period ending March 31 · 1931, could be prepared and circulated in time, visitors to the antipodes in 1932 would be provided with all the information they need for the study of the local experiment stations and of the results obtained. If other parts of the Empire adopted the same practice, the 1932 meeting of the Imperial Agricultural Research Conference would mark a distinct step in advance in providing that effective publicity which is now becoming so necessary in scientific work, not only for the workers themselves, but also for the public from whom the funds are ultimately derived."

There seems to be an overwhelming case against the present system of annual reports. The arguments in favour of some method such as the quinquennial review are exceedingly strong.

ALBERT HOWARD

INDORE,
Jan. 26th, 1931.

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